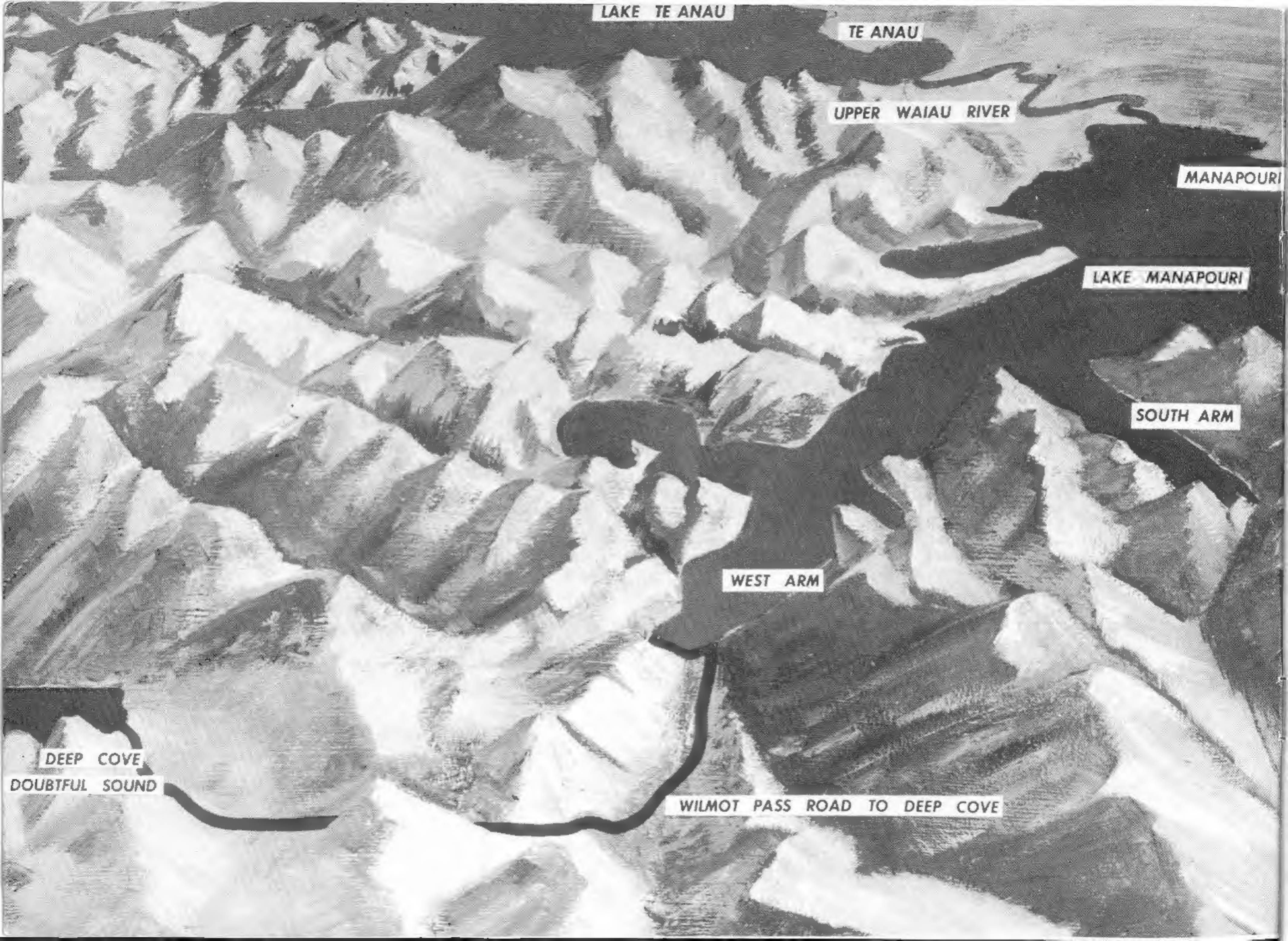
POWER FROM MANAPOURI


LAKE TE ANAU
TE ANAU
UPPER WAIAU RIVER
MANAPOURI
LAKE MANAPOURI
SOUTH ARM
WEST ARM
DEEP COVE
DOUBTFUL SOUND
WILMOT PASS ROAD TO DEEP COVE

The Manapouri - Doubtful Sound hydro-electric project is in Fiordland National Park, which is in the Southland district of the South Island of New Zealand. The project draws on Lake Manapouri for water, which will drop vertically 700 ft to an underground powerhouse and then flow through 6 miles of tunnel to discharge in the sea at Deep Cove in Doubtful Sound. △ Fiordland National Park is a vast region, majestic in scenery. Of 3 million acres, it is one of the world's largest parks and occupies the entire south-western sector of the South Island. △ Gaunt peaks and sheer rock walls typify its mountain ranges and reflect the extensive glaciation of relatively recent geological times. Glaciers retreating left chasms which became fiords and dammed valleys which became beautiful lakes. △ The largest lake is Te Anau, which covers 138 sq. miles and is 663 ft above sea level in a great glacial basin. The small township of Te Anau is at its southern end. △ Lake Te Anau is linked to the nearby Manapouri (lake of the sorrowing heart) by the south-flowing Waiau River. With forested islets and surrounding high mountains. Manapouri is considered the most beautiful lake in New Zealand. It is 80 ft lower than Te Anau, covers 55 sq. miles, and is the deepest lake in the country with a maximum sounding of 1,455 ft. (872 ft below sea level). △ To the west, rugged mountains, on which forest runs up to snow, separate these lakes from the Tasman Sea, where the coastline of deeply indented fiords is of great beauty. This region is among the world's greatest tourist attractions. △ Hydro-electric development was first considered in 1904, but the scheme to use the waters of Te Anau and Manapouri in a 600 ft fall through the mountains into the sea at Doubtful Sound was put aside because of its magnitude and the inaccessibility of the area. △ In 1959 the scheme was revived because of a proposal to build an aluminium smelting plant at the deep-sea port of Bluff, near Invercargill. Investigations were begun at West Arm on Lake Manapouri by Comalco Industries Proprietary Ltd., of Australia, but in 1963 the New Zealand Government assumed responsibility for the development. Comalco, however, retained an option on part of the electrical output.

VAST AND MAJESTIC

How This Land Was Formed

The high mountains around Te Anau and Manapouri are mainly of schist and gneiss. Both are formed by the alterations, or metamorphism, of ancient sedimentary and volcanic rocks that were themselves formed at great depth in the Ordovician period 450 million years ago. Later, by slow uplift and erosion the present mountain ranges emerged.

During their burial in the Cretaceous period, 100 million years ago, the earth temperatures and pressures were very high, and new minerals were created, such as the mica that gives the schists their sheen and the quartz and felspar that make the gneisses like granite. Sulphides, including those of copper, are common in these rocks, but they occur only as minute crystals, and concentrations are not economic.

Both types of rock are clearly exposed around the fiords, and in the walls of the access and tailrace tunnels of the Manapouri Power Development, where evidence of their former deep burial is shown by intense shearing, and by veins of white quartz and pegmatite which criss-cross through the gneiss in fantastic patterns. In the later Oligocene period, 35 million years ago, limestones were deposited on schist and gneiss. In them are the extensive caves across the lake from Te Anau that are visited by tourists.

The landforms of Fiordland were carved out of the extremely hard rocks in the Pleistocene (Ice Age) period that lasted from three million to 10,000 years ago. Ice itself was the main agent. Glaciers carved deep gorges during their slow movement to the sea. In the west, they formed fiords, like Doubtful Sound, whose steep sides continue deeply below sea level. Smaller subsidiary glaciers left much shallower valleys.

In the east the glaciers melted away in the river valleys and vast quantities of rock and clay in the ice were deposited as moraine around the ice snout. The irregular hills at the southern ends of Te Anau and Manapouri lakes were formed from the old moraines of glaciers.

Upstream, the glaciers carved the deep valleys of the lakes; and downstream the rivers carried away boulders and clay to leave extensive river flats.

Location and Access

The hydro-electric development is between the head of the West Arm of Lake Manapouri and Deep Cove at the head of Doubtful Sound, including the Wilmot Pass.

From Invercargill, Manapouri can be reached by road, by rail and road, or by air.

By road the distance is 99 miles on a sealed highway. Buses leave Invercargill daily, connecting with launches on Lake Manapouri. Buses also leave from Lumsden for Manapouri and Te Anau.

The railhead for Manapouri is Mossburn, 49 miles to the east.

Air travel is by private charter amphibians from Invercargill and Te Anau.

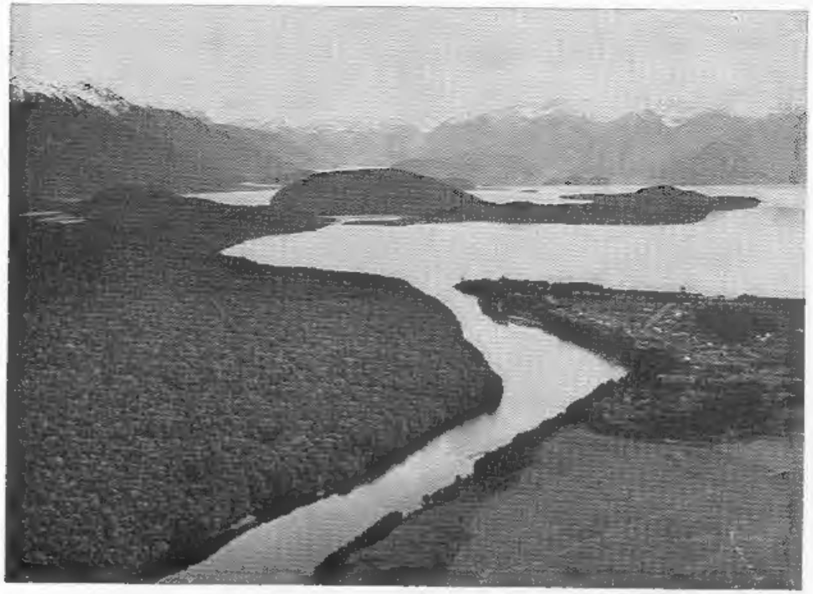
△ West Arm is reached by launch from Pearl Harbour, Manapouri. The 80-seat launch *Fiordlander* leaves regularly for the West Arm site, and the 20 mile journey takes an hour.

Amphibians fly from Te Anau or Manapouri by special arrangement.

△ Doubtful Sound, formerly accessible only by sea or amphibian, is now served by a bus service, from West Arm, Lake Manapouri, by way of the Wilmot Pass road.

In the interests of public safety, visitors are not permitted to tour the engineering site unless in arranged parties approved by the Bechtel Pacific Corporation or the New Zealand Government. During the earlier part of the work the Wilmot Pass road carried only heavy construction traffic.

The mountains between Doubtful Sound (foreground) and West Arm, Lake Manapouri (background) rise to 4,000 ft above the tailrace tunnel route



Above right: *Manapouri township looking towards the West Arm. The Lower Waiau River in foreground*

Above left: *West Arm, Lake Manapouri, at earliest stage of project*

Right: Wanganella *moves to her mooring in Deep Cove in August 1963. In centre, the Lyvia Valley rises to the 2,200 ft Wilmot Pass, which the road to Manapouri now crosses*

Names and Places

LYVIA RIVER

Lyvia River was named by Captain J. L. Stokes of HMS *Acheron* when he explored Doubtful Sound in 1851. Previously it had been called by the Maori Kahui-kakapo, "meeting place of the kakapo".

HALL ARM

Sailing down Malaspina Reach in Doubtful Sound and passing Rolla Island, the traveller finds Hall Arm opening out to his right and running southwards. He is almost immediately among jagged, towering heights. To the west of the entrance, Commander Peak with its outjutting top looms 4,000 ft above Davidson Head. Travelling the narrows he finds himself in a great rocky corridor with the view ahead of stark peaks dominated by Mount Danae (4,800 ft). Towards the end of the arm the view softens. The lower slopes of the great mountains are covered with a profusion of native bush broken here and there by waterfalls. Hall Arm was named by Captain J. L. Stokes of HMS *Acheron* when he explored Doubtful Sound in 1851. It is not known who Hall was.

Early view of South Arm, Lake Manapouri, showing Grebe Valley which the transmission line will follow. South Arm camp site is now built on right bank of Grebe River

BRASELL POINT

Brasell Point is at the southern end of Deep Cove and was named by the New Zealand Geographic Board for Mr George Brasell, owner and master of the ship *Miss Akaroa*. Mr Brasell, born at Lyttelton, was in his youth a yachting champion and became a notable trawler skipper whose superior seamanship contributed to several successful search and rescue operations. In recent years he used *Miss Akaroa* for survey work on the Fiordland coast.

TE ANAU

This name is said to have been given to the lake by the high chief Rakiahautu about A.D. 850. Landing in Nelson, he worked his way down the middle of the South Island, naming the long chain of lakes there. Te Anau is probably more correct as Te Anau-au, which means "cave of swirling waters", for the caves at Tunnel Burn.

DOUBTFUL SOUND

On his first voyage to New Zealand in 1770 Captain James Cook gave the name Doubtful Harbour to what is now known as Doubtful Sound, apparently because he doubted if a ship, once in the inlet, could return against the prevailing westerly winds.

WILMOT PASS

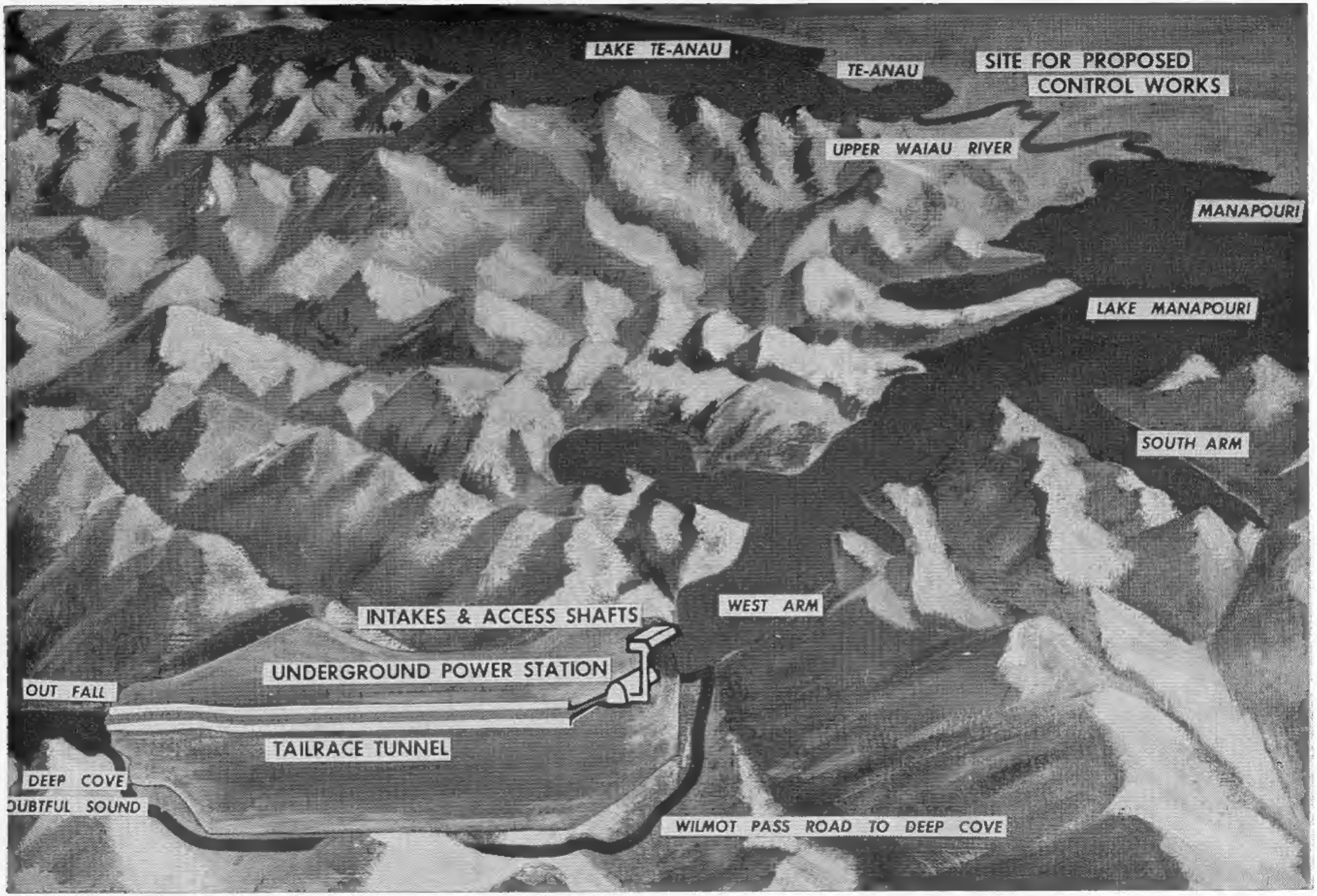
On the walking route between the head of Lake Manapouri and Deep Cove in Doubtful Sound, this pass was discovered in 1888 by R. Murrell. He was searching for Professor Mainwaring-Brown, who had been lost while exploring the valley of Disaster Burn. The pass was named for the surveyor E. H. Wilmot, who some years afterwards confirmed Murrell's discovery.

Surveyor sighting in funnel to ensure correct alignment

MANAPOURI

Manapouri was one of the lakes named by the high chief Rakaihautu when he visited New Zealand in his canoe *Uruao* about A.D. 850. He called it Roto-ua (rainy lake), but it later came to be known as Moturau, either because of the literal meaning of the word (hundred islands) or because of the legend that the lake was formed by the tears of two sisters, Moturau and Koronae.

Moturau was also the name given to the lake in 1852 by the first Europeans to discover it, C. J. Nairn and W. H. Stephen. It is thought that in 1862 surveyor James McKerrow misinterpreted this name for Manapouri, a variation of Manawapouri, which is usually translated as "lake of the sorrowing heart".


LAKE TE-ANAU
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SITE FOR PROPOSED
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MANAPOURI
LAKE MANAPOURI
SOUTH ARM
WEST ARM
INTAKES & ACCESS SHAFTS
UNDERGROUND POWER STATION
OUT FALL
TAILRACE TUNNEL
DEEP COVE
OUBTFUL SOUND
WILMOT PASS ROAD TO DEEP COVE

The Development

Of a planned capacity of 700,000 kilowatts of electricity, the Manapouri hydro-electric scheme involves diverting water from Lake Manapouri through an underground powerhouse at the head of the West Arm of the lake. The water then leaves by tunnel to discharge into the sea at Deep Cove at the head of Doubtful Sound.

The scheme can be divided into seven sections:

- A tailrace tunnel under the mountains from Deep Cove to the underground powerhouse at West Arm on Lake Manapouri.
- A tunnel to give access to the site of an underground powerhouse at West Arm.
- The subterranean chamber for the underground powerhouse, and, on the surface, the associated control buildings and switchyard.
- A highway over Wilmot Pass to link the two phases of the development.
- Access roading and bridging for the erection and maintenance of transmission lines.
- Transmission lines.
- Control works on the Waiau River.

To complete the scheme in five years requires careful planning. In principle the scheme is simple, for there is no major dam and much of the work is tunnelling. However, the project has unique problems.

Remoteness, difficult access and communications, heavy rainfall (250 in. annually), snow, and sandflies affect not only progress of the work but also the well-being of the men employed.

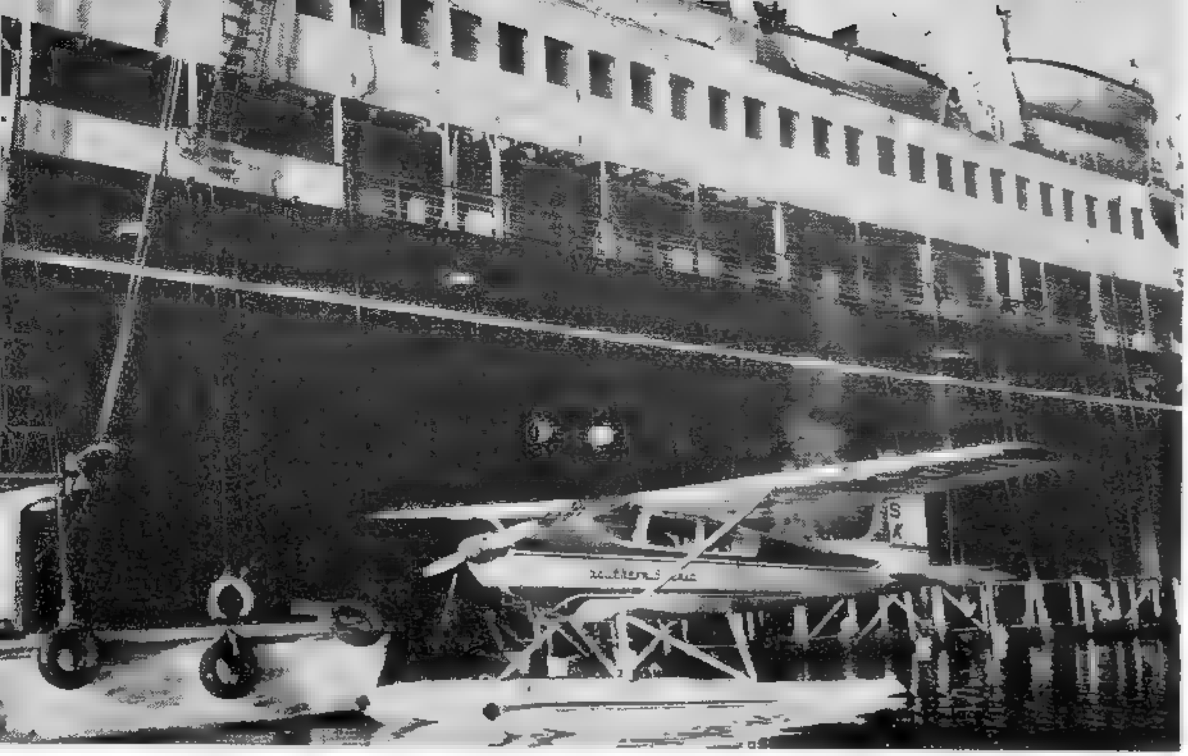
Accommodation for the hundreds of workers on the tailrace tunnel at Deep Cove was a major problem, for Deep Cove is a wet and lonely place. Isolated by high mountains, rising almost vertically from the water, Deep Cove, before the project began, was accessible only by sea or over Wilmot Pass.

For accommodation the contractors bought the trans-Tasman liner *Wanganella*, which in August 1963 was converted into a floating hostel at Deep Cove. The *Wanganella* also served as a floating dock, her derricks being used to unload stores and equipment.

As Deep Cove was the best access for heavy plant and equipment for both Deep Cove and West Arm, a new cantilever wharf, suitable for ships up to 13,000 tons, has been built close to where the *Wanganella* is berthed. Building the wharf was difficult, as there were no shelves on which to place foundations, the steep mountainside continuing straight down beneath the water for several hundred feet.

Port-of-entry customs regulations apply, as do precautions against introducing pests, or human, animal, and vegetable diseases.

A resident policeman has these responsibilities in addition to his normal duties.



Accommodation ship Wanganella with Southern Scenic float plane in Deep Cove

Sleeping accommodation for workmen on hostel ship Wanganella

The library on the Wanganella

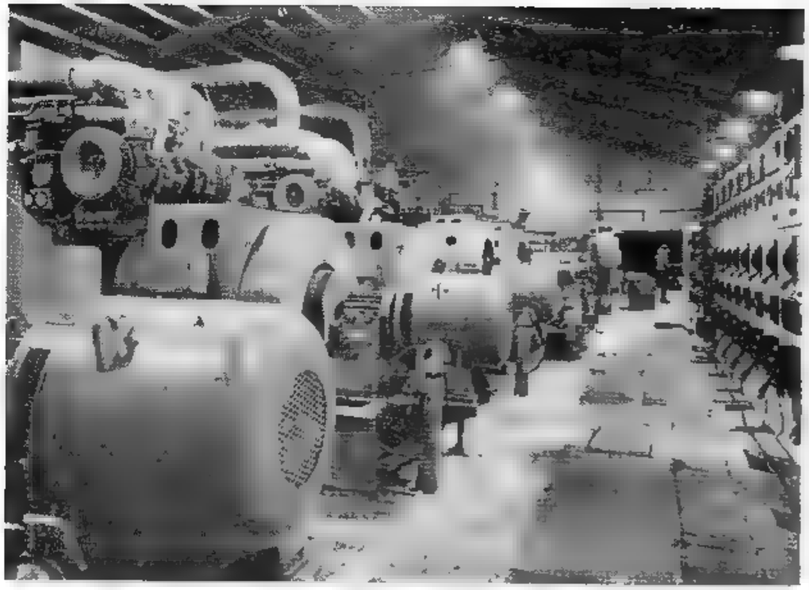
Dining accommodation on hostel ship Wanganella at Deep Cove

Ambulance on the Wanganella at Deep Cove is ready 24 hours a day. Mount Barber is in background

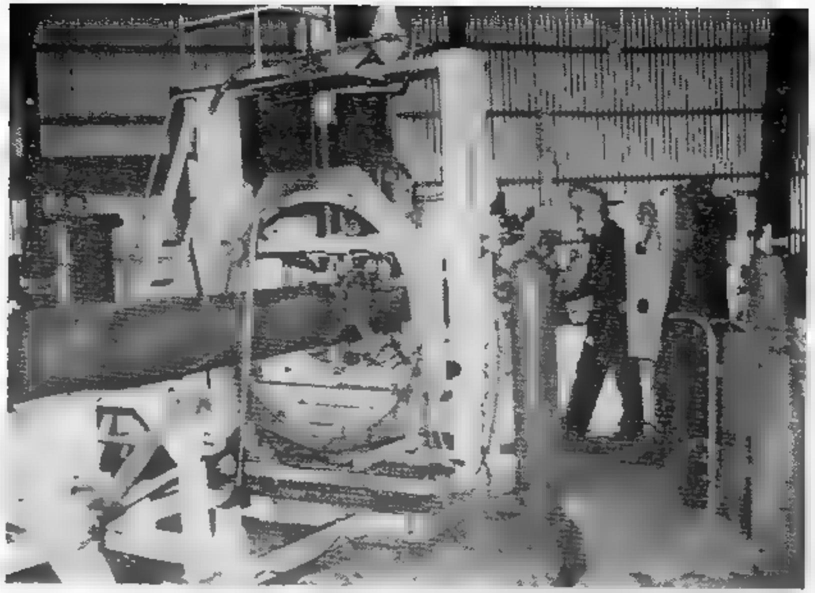
Schie Lloyd, *first overseas vessel to berth at the new cantilever wharf at Deep Cove, unloading the first generator for the powerhouse at West Arm*

New Zealand Police officer on Wanganella signs customs papers

Permanent wharf at Deep Cove under construction. The 150 x 53 ft wharf will be used by ships up to 13 000 tons



(Photo: English Electric Co. Ltd)



Above left: *The electricity generating powerhouse at Deep Cove, large enough to supply a moderate-sized city*

Above right: *Manufacture of pipes*

Right: *Servicing installation, tailrace tunnel at Deep Cove. Tailrace portal is behind the buildings*

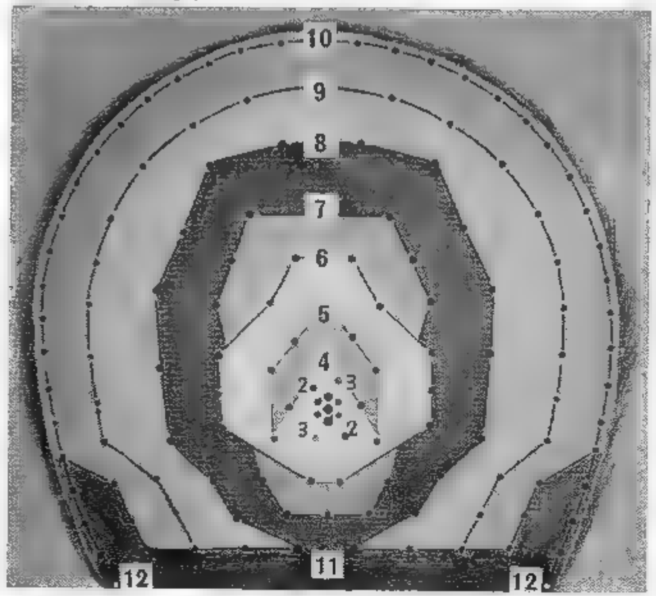
Portal of tailrace tunnel at Deep Cove. Pumping station is on right

Switchyard inside tailrace tunnel

Drilling jumbo, No. 3, tailrace tunnel, Deep Cove

Explosive truck at face of working

Drilling and firing pattern, tailrace tunnel



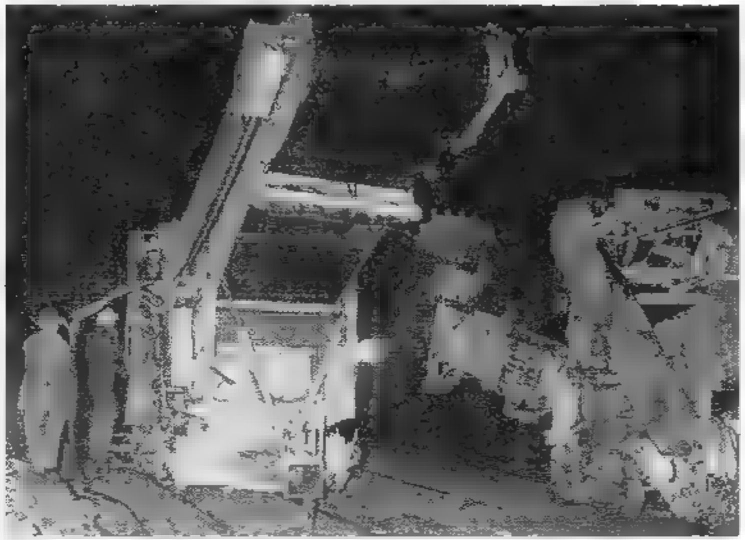
The Tailrace Tunnel

The tailrace tunnel, driven under the mountains from Deep Cove to the underground powerhouse at West Arm, and 32,250 ft long (6 miles), has a modified horseshoe section 30 ft high, reinforced with rockbolts and wire mesh and lined throughout with concrete.

The tunnel was begun on 4 February 1964, when the Prime Minister (Mr Holyoake) fired the first shot. Drilling and clearing the debris were done by simple mechanical methods at first and trucks were used to remove spoil, but later a railway system was laid and more advanced tunnelling techniques were used, enabling the work to be done quicker.

General view of servicing area of Deep Cove end of tailrace tunnel. Portal is at top left of photo

Drilling from jumbo in tunnel



"Muckers" at work removing spoil from face

The rail trucks, each with a capacity of 14 cu. yd., are drawn by electric locomotives, and dump most of the rock spoil at the head of Deep Cove to form a spillway embankment, the rest being used as aggregate for concrete to line the tunnel. About 32 cu. yd. of spoil is removed for each foot of tunnel driven.

A 45-ton steel jumbo, or drilling rig, was built inside the tunnel. Mounted on rails laid along the extreme sides of the tunnel, the jumbo is 23 ft high and has four platforms at various levels, carrying up to 18 high-speed drills, driven by compressed air. The drills bore 4 to 30 ft into the rock face, depending on the type of rock. The jumbo is moved to the face for drilling, but is moved back 450 ft during blasting.

Drilling is to a specific pattern, which is shown in the accompanying illustration. All except the centre three holes are packed with explosive charges, wired and fired electrically, in the sequence shown by the numbers, at intervals of half a second. The centre holes are made bigger than the others, so that when the initial charge (No. 1) is fired the weakened centre offers little resistance and the debris falls into it. Later firings are designed similarly, the aim being to disturb the roof as little as possible.

Explosives are brought to the face in a special rail truck under strict safety precautions. While the charges are being placed, wired, and fired, the men go behind the firing box, at least 1,000 ft from the face

All electricity is disconnected, the men placing the charges working in darkness.

After a blast two special rail-mounted mucking machines, or mechanical shovels with conveyors, automatically load the spoil into tipping rail trucks designed for the job. The muckers can deliver several tons in a few minutes.

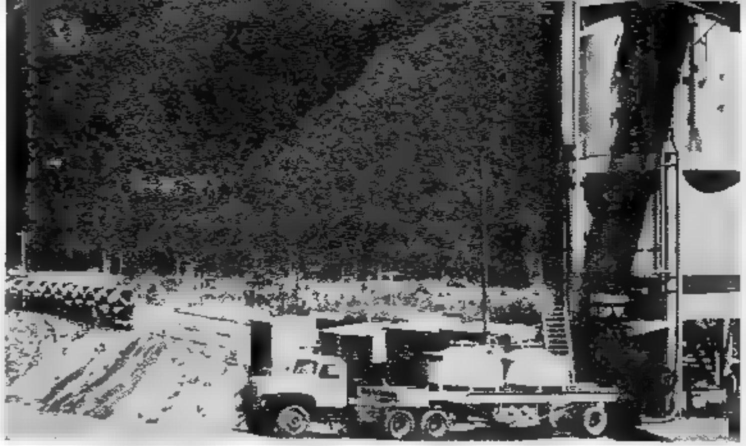
A switchyard at the face enables the trucks to be shunted. After a complete blasting and excavating operation the switchyard, which is mounted on a sliding steel floor, is moved forward by hydraulic jacks to the new face. A single railway line is then added to the rear of the floor and the tunnelling sequence is ready to start again. This is the first time such a method has been used in New Zealand.

Wet, humid conditions prevail in the tunnel as it penetrates deeper into the mountains and water pours continually from the face and at points along the unlined portion. Some 5,000 gallons of water a minute are pumped from the tunnel.

CONCRETING

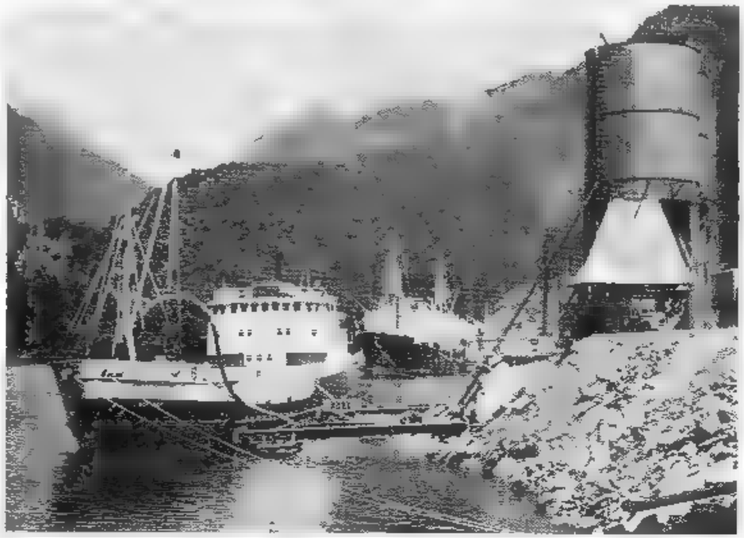
Lining the tunnel with concrete is necessary to prevent erosion of the walls and to ease the flow of water. The lining will average 15 in. in thickness, and to prevent high external hydraulic pressure on its surface a pattern of drainage holes will be drilled through the lining into the rock. In local areas, where the rock is less solid, the concrete lining is being reinforced.

The huge quantities of cement for the job are shipped in bulk to Deep Cove and are transferred by suction to three big silos ashore.



Cement vehicle, batcher, and rail mixer trucks, Deep Cove

Finished portion of tail-race tunnel, fully lined



Cement ship, Ligar Bay, unloading bulk cement at Deep Cove. Wanganella in background

Concrete aggregate plant at servicing area, Deep Cove

A special vehicle, carrying up to 17 tons in its two hoppers, transfers the cement from the silos to a batching plant about a mile away, where it is mixed with aggregate and batched into specially designed rail mixing trucks. With additives and water in proper proportions, the mixer on the truck is rotated electrically for six minutes before starting its journey into the tunnel.

Underground, the concrete is fed on to a conveyor, built on to a tunnel-shaped, rail-mounted formwork 96 ft long. From the conveyor the concrete is pumped into the form. Men working inside the form—between it and the rock walls, and often with only 12 in. of headroom—see that the concrete is properly placed and compacted.

All mixes of concrete are thoroughly tested in a laboratory by technicians to ensure that they will withstand the stresses that will be applied to them.

Concrete samples being tested in laboratory

Deep Cove Workshops

The equipment and machinery used at Deep Cove require constant servicing and, to do this, extensive workshops have been built. Fully equipped, they are also geared to manufacture the air ducts and pipes used in both the tailrace tunnel and the access tunnel at West Arm.

A powerhouse, with enough capacity to light a moderate-sized city, has been built in a clearing on the mountainside, and an air-pumping station to supply the air-powered drills and tools has also been erected.

Formwork in the 6 mile, 30-ft-high, tailrace tunnel

West Arm

While work began at Deep Cove, land was cleared at the head of West Arm, Lake Manapouri, and buildings put up for the men and machinery to construct the access tunnel to reach the site of the underground powerhouse, intakes, penstocks, control buildings, and switchyard.

Stores and equipment were ferried across the lake by barge, and an electric generating plant and workshops were erected near the lake shore. Later, a large gymnasium with a small store was built for the all male population. A post office was opened in another corner of the gymnasium building to provide full postal and banking facilities. A well appointed wet canteen was built in front of the building.

At first the only way to reach the site, except by air, was by launch *Fiordlander*, which ran a twice daily service from Manapouri. Now the contractors run their own two launches, *Endeavour* and *Resolution*, to transport workers and small stores.

Across the lake, beside the Manapouri village, a construction village is being built to house many married workers, and these men will be taken daily to and from the project by the launches.

West Arm Camp, Lake Manapouri

Unloading barge from Supply Bay to West Arm, Lake Manapouri

Mess hall, West Arm camp, Lake Manapouri

Manapouri construction workers' village

Launches Resolution and Endeavour at Supply Bay

West Arm camp from lake with launch Fiordlander in foreground

Access Tunnel

Using permanent service shaft above powerhouse, muck skip raises spoil in two minutes against 40 minutes through the 1½ mile access tunnel

Work on the access tunnel began in January 1964. It is 6,700 ft long, with a modified horseshoe section 22 ft wide, driven on a gradient of 1 in 10, and spiralled to enable heavy plant to be taken by road transporters to the powerhouse. The roof of the tunnel is not lined with concrete, but is reinforced throughout with rock bolts and wire mesh.

Tunnelling techniques similar to those used in the tailrace tunnel were employed, but no railway tracks were laid. Crawler machines were used and the spoil was taken to the surface by heavy trucks.

Some spoil from the tunnel was used to help build the Wilmot Pass road and West Arm camp, the remainder being dumped and spread on swampy land where the Spey River joins Lake Manapouri.

To remove foul air from the face and tunnel, big battery-operated extractor fans were fitted, and compressors supplied air to work the drills and some of the pumps.

Excavation in progress for the machine hall of the powerhouse

Powerhouse

Rock where the powerhouse gallery is being excavated is expected to be good, and so the gallery is designed to be unlined, but reinforced by grouted rockbolts. Only the minimum excavation is being made.

The powerhouse machine hall, 700 ft below the surface, is to be 364 ft long and 59 ft wide and will house seven turbo-generators, each of 100,000 kilowatts capacity. The underground building will have several floors and will be 128 ft high.

The powerhouse layout will be of seven units, each comprising a generator, a transformer, a circuit-breaker, and a switch bay.

TURBINES

Only four turbines are to be installed initially. They are of the Francis type and are rated at 142,000 horsepower at 250 revolutions per minute under a net head of 490 ft of water. The turbines can be serviced from above.

GENERATORS

Each generator will have a continuous rating of 105,000 kVA at 0.95 power factor. The generator voltage will be 13.8 kV and the frequency of 50 cycles will be the same as that of the national grid.

TRANSFORMERS

Eight vaults are to be excavated near the downstream wall of the machine hall to house seven service transformers and one spare.

Each generator will be connected to its corresponding transformer by a segregated phase metal-enclosed bus.

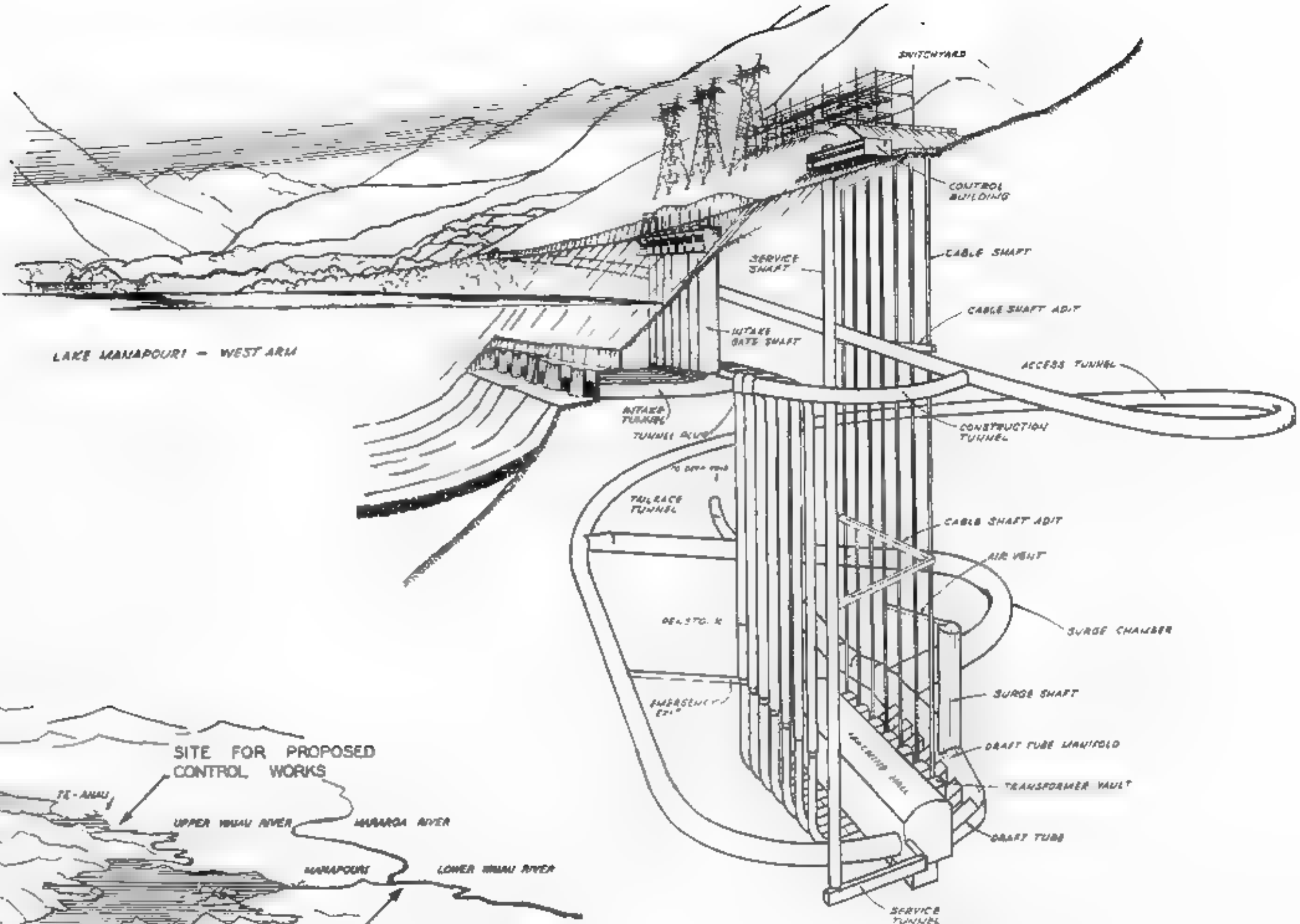
Two 145-ton overhead travelling cranes are to be installed in the machine hall, in which an air-conditioning system will control temperature and humidity. Sufficient air will be exhausted up the cable shafts to control any heat rise in the shafts; and a system to exhaust air from the access tunnel is planned.

Attendants will get to the powerhouse mainly by a service lift, for which the old exploratory shaft was enlarged. It will connect the machine hall with the control building and will also serve as access to cable inspection platforms within the shaft. In the shaft also are the air intake and exhaust ducts and an emergency escape ladder.

SWITCHYARD OR OUTDOOR STATION

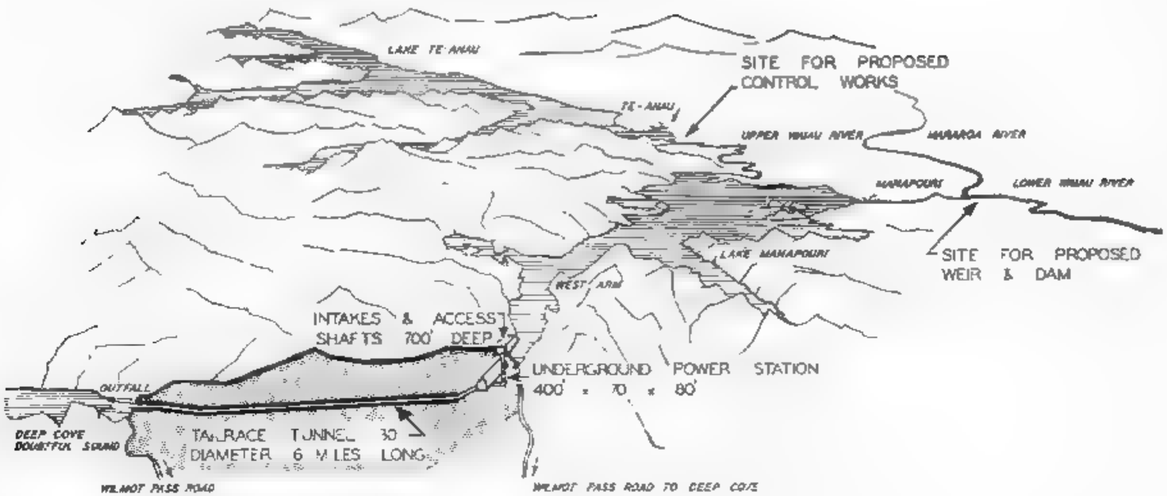
A switchyard or outdoor station is to be on the surface immediately above the machine hall. Occupying an area of 400 ft by 140 ft, it will serve three outgoing 220-kV transmission lines and could serve a fourth if needed. Transmission from the transformer vaults to the switchyard will be through shafts.

Workings in access tunnel, West Arm



Schematic layout of complete power plant, West Arm, Lake Manapouri

Perspective of Manapouri power scheme. (Compare with aerial view of district on page 4.)



Intakes and Penstocks

All seven intakes and penstocks are to be built initially, and each turbine will have its own water supply.

Control of the intakes will be by fixed wheel gates designed to work under unbalanced hydraulic conditions. An air duct will be built into each gate shaft, and individual maintenance chambers, with hoisting gear mounted above them clear of lake level, will be provided.

A single upstream sealing bulkhead gate will be installed for use in any of the seven intake shafts. A gantry crane, moving on rails mounted on the maintenance chambers, will allow installation of the bulkhead gate and general maintenance.

The 12-ft-diameter penstock shafts are to be rockbolted and then concrete lined for their first 110 ft, after which a transition to steel lining will take place. The space between the lining and the rock will be filled with concrete.

DRAFT TUBES, MANIFOLD, AND SURGE CHAMBER

Each turbine will exhaust into a draft tube. Of the elbow type, the tubes will be lined with concrete, and the cone and elbow

Work at powerhouse face, jumbo in position

Switchyard under construction, West Arm

with steel. Hinged gates with hydraulic operators will allow each tube to be closed for dewatering.

Water discharged from each draft tube will enter a manifold—a vertical-sided, horseshoe-shaped gallery—which is to be reinforced with rockbolts, wire mesh, and mortar. The tube will vary uniformly in width from 21 ft to 36 ft and in height from 17½ ft to 50 ft, the greatest dimension being at a point where the surge-chamber shaft is located. At the end of the manifold where water enters the tailrace tunnel, the manifold will be 42 ft high.

The surge chamber, required at the closed end of any long conduit, will dampen pressure fluctuations which occur regularly during normal hydro station operations and can be accentuated by rapid loss of or sudden increase in load.

CONTROL BUILDING

The control building will be above ground at the top of the service lift shaft. Of reinforced concrete, it will be the nerve centre for the development, containing offices, control room, cable spreading room, and machinery for ventilation and lift control. Access will be by road past the intake structures. A lift from this building will give access to the machine hall.

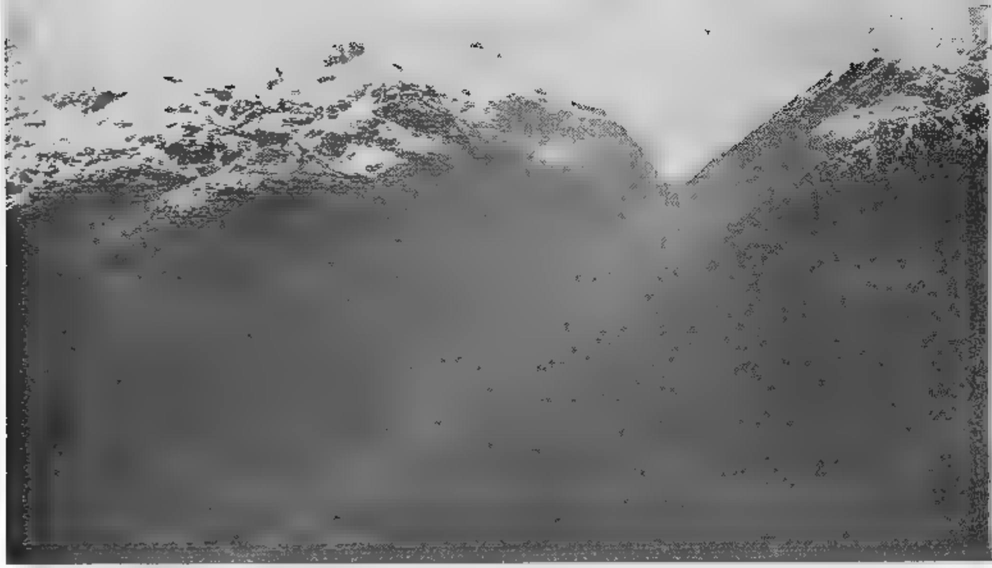
Wilmot Pass Road

The two major phases of the development are connected across Wilmot Pass by a highway, constructed in rigorous climatic conditions. Both ends were started about the same time as the tunnels. For part of its 14 miles, up the Lyvia River valley to Wilmot Pass (2,200 ft) and down Dashwood Stream and Spey River valley, the highway follows the original tramping track over some of the most rugged country in New Zealand.

For two years men toiled in winter and summer to form the winding road to the summit, their progress slowed by snow, ice, and heavy rain. Small streams flooded by heavy rains trapped vehicles and rockfalls on new sections hampered the work.

Now concrete bridges span the streams, and although slips occur they are easily cleared. Machinery and supplies from overseas and coastal ships berthing at Deep Cove can be easily transported by road to the underground powerhouse at West Arm.

Previously closed, during the earlier part of the hydro works construction, Wilmot Pass road is now used by buses between West Arm and Doubtful Sound. The road has opened up wonderful mountain vista previously seen only by infrequent trampers.



Wilmot Pass, looking along Dashwood Valley to the pass and Doubtful Sound

Wilmot Pass road, construction work in progress

Early construction of Wilmot Pass road in summer

Work starting on the bridge over the Lyvia River which flows into Deep Cove

Bridge abutment Lyvia River, Doubtful Sound on Wilmot Pass road

Lyvia River bridge during construction

Left:

Bridge crossing Spey River which runs into Lake Manapouri

Lower left:

Borland Canyon - Shallow Lake heading of transmission line access road. This road will connect with that being driven from South Arm up Grebe River Valley

Lower right:

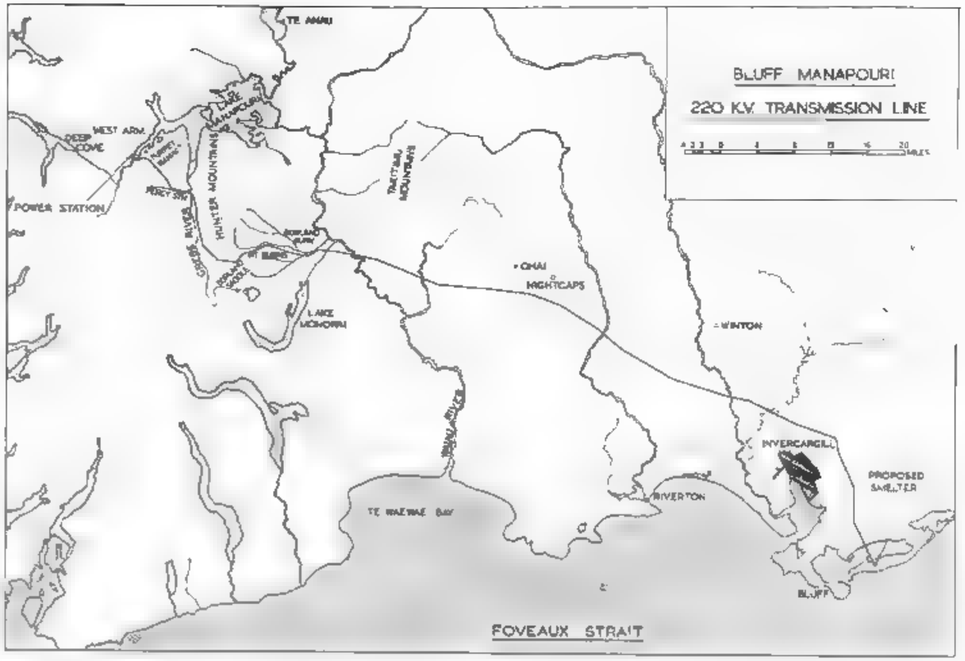
Typical cut on transmission line access road construction

Transmission Line

From the switchyard above the powerhouse the transmission line will run southward crossing the mouth of the Spey River and then passing over the Turrett Range by way of Wolf Flat, a plateau between 3,000 ft and 3,500 ft above sea level.

The route then runs down the valley of the Percy Stream to the Grebe River, up the Grebe Valley, across the Borland Saddle in the Hunter Mountains at 3,500 ft to the south branch of the Borland Burn, and thence to Monowai. It passes close to the Monowai power station, which was built in the early 1920s to supply Southland, and then runs generally south-east within a few miles of the historic mining townships of Ohai and Nightcaps, across the Southland Plains to Makarewa on the outskirts of Invercargill, and on to the smelter site at Bluff. Another line will connect the smelter to a substation of the national grid at Invercargill.

It is just over 100 miles from Awarua Bay (Bluff Harbour) to the generators at Manapouri. For 70 miles the route is in open rolling country; then abruptly it plunges into the rugged bush-clad mountains of Fiordland National Park. Here construction of the main access road and bridges was in itself a formidable and expensive task. The approaches to Wolf Flat are so steep that this sector, crossed by some 15,000 ft of line, will not be roaded. Flying foxes and probably helicopters will be used to reach transmission tower sites.



Air track drill on transmission line access route between Monowai and South Arm, Manapouri

Control of Lake Manapouri

In the first stage of the Manapouri - Te Anau development there will be a low, rock-fill weir just below the confluence of the Waiau and Mararoa Rivers. By controlling the flow from Lake Manapouri it will tend to keep the minimum lake level a little higher than it might otherwise be.

For final development, however, it will be necessary to raise the level of Lake Manapouri substantially. This will be done by building in place of the weir a concrete dam and spillway to a height required to keep the lake at a level regarded as normally full. This is known as the controlled level.

The controlled level will be decided by engineering investigations, still incomplete, but it will not exceed 620 ft. Probably it will be somewhere between 600 ft and 610 ft.

The most likely level, 610 ft, is 27 ft above the average natural level of 583 ft and is 55 ft below the maximum controlled level permitted by the Manapouri - Te Anau Development Act.

The Act gave the aluminium company the right to raise Lake Manapouri 82 ft above its average natural level which would have brought it to 665 ft, the level of Lake Te Anau.

A controlled level of 610 ft can be got by a simple and economical dam. Its estimated cost is less than £4,000,000. For this sum it will be possible to generate 350 million more units of electricity every year than if the dam were not built and the lake raised. This extra energy, at less than a farthing a unit, will be a good bargain.

Top: Surprise Bay, Lake Manapouri (left) and Circle Cove (right) with Hope Arm in background

Centre: Site of the Te Anau lake control approximately 3 miles down the Waiau from Lake Te Anau. The weir will be at the cleared patch of brush on the bank, right centre

Lower: The Manapouri weir will be built approximately a mile below the area shown, below the meeting of the Mararoa and Waiau Rivers

Scenery Preservation

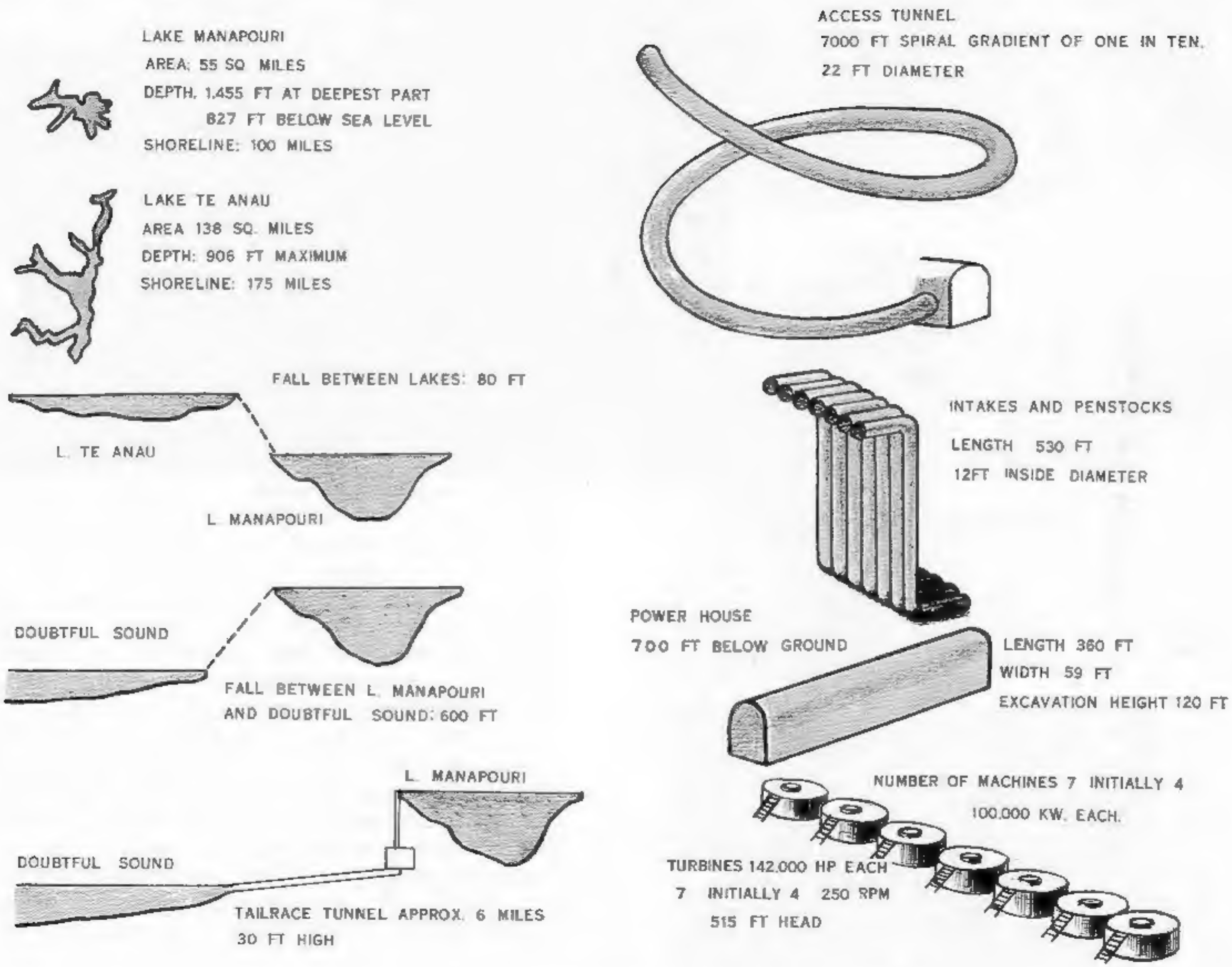
Lake scenery worth preserving; Lake Manapouri from Waiau River outlet

Fiordland is a national park vast in area and containing (in the words of the National Parks Act) "scenery of such distinctive quality or natural features so beautiful or unique that their preservation is in the national interest". Many people would like to see Fiordland developed only enough to allow visitors to see its sights and enjoy the recreational activities it offers. However, some of the lakes and fiords that led to the 3 million acres being constituted a national park make Fiordland a valuable source of hydro-electricity.

The national interest required the hydro-electric development, but the legislation authorising the scheme made particular reference to preservation of scenery. From the outset the project has been planned and executed to keep any harm to natural features to a minimum. For instance, the major installation—the powerhouse at West Arm—is being built underground.

Planners, engineers, and construction staff have worked in harmony with those administering Fiordland National Park, even though the protection extended to the playful but destructive mountain parrot, the kea, has tried the patience of project workers at times. When the scheme is completed and construction scars are healed the scenery of the West Arm and Doubtful Sound regions will be unimpaired. One thing has been changed as a by-product of the power project: a region previously the preserve of a few hardy trampers and hunters is now wide open for all visitors to enjoy, with public transport running over the Wilmot Pass to Doubtful Sound.

Facts and Figures



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Organisation

New Zealand Electricity Department manages all Government-owned generating stations and distributes electricity through its grid system to local supply authorities.

Ministry of Works is responsible to the New Zealand Electricity Department for all civil engineering work and has overall charge of the Manapouri project.

Bechtel Pacific Corporation, an American firm of engineers, retained as consultants. The corporation is in charge of engineering, procurement, and management of construction.

The work is being done in many separate contracts, including:

TAILRACE TUNNEL

JOINT VENTURE – Utah Construction and Mining Co., San Francisco.
W. Williamson Construction Co. Ltd., New Zealand.
Burnett's Motors Ltd., New Zealand.

WEST ARM ACCESS TUNNEL

JOINT VENTURE – Morrison-Knudsen of New Zealand Ltd.
Downer and Co. Ltd., New Zealand.
Fletcher Construction Co., New Zealand.

UNDERGROUND POWERHOUSE

Utah Construction and Mining Co., San Francisco.

WILMOT PASS ROAD

JOINT VENTURE – Utah Construction and Mining Co., San Francisco.
W. Williamson Construction Co. Ltd., New Zealand.
Burnett's Motors Ltd., New Zealand.

TRANSMISSION LINES ACCESS ROADING

Borland Canyon to Shallow Lake

JOINT VENTURE – Herron Contracting Co. Ltd.
Darrell McGregor (Contracting) Ltd.

Grebe Valley to Percy Valley

Roadways (New Zealand) Ltd.

Wolfburn Section

D. H. Robinson Ltd.

SPEY RIVER BRIDGE—WEST ARM

J. E. R. Contractors Ltd.

SOUTH ARM CAMP

Transmission Line Camp

R. Richardson Ltd.